ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

PROJECT NO. 3 - TOXIC GASES IN ARMORED VEHICLES

Partial Report

On

Sub-Project No. 3-9, Determination of the Ventilation Requirements for Gas-Proofing Tanks

SUBJECT: VENTILATION REQUIREMENTS FOR GAS-PROOFING TANKS OF THE M-4 SERIES

Project No. 3-9

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ARMORED FORCE MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

Project No. 3-9
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PARTIAL REPORT ON VENTILATION REQUIREMENTS FOR GAS-PROOFING TANKS OF THE M-4 SERIES

1. PROJECT: 3-9 - Determination of the Ventilation Requirements for Gas-Proofing Tanks.

a. Authority - Letter, Commanding General, Headquarters Armored Force, Fort Knox, Kentucky, 400.112/6 GNOHD, dated September 24, 1942.

b. Purpose - To determine the important leakage areas in the series M-4 tanks and the amount of sealing required to maintain adequate pressure for gas-proofing the tank with ventilation equipment of practical size and power consumption.

2. DISCUSSION:

a. Methods - The fighting compartment of an M4A2 tank was sealed as completely as possible and air delivered into it at measured rates by an external fan. For each rate of air flow, the corresponding static pressure within the tank was noted. Following this, various leakage areas were successively unsealed and new pressure volume curves obtained. The difference between any two successive areas represented the rate of leakage contributed by the particular area which was opened up. Pressure-volume curves obtained in this manner are shown, for the important sources of leakage, in the Appendix.

3. CONCLUSIONS:

a. The 75 mm gun mount is the most important leakage area and the effective sealing of this area is essential to the development of a gas-proof tank with a pressure ventilating system of practicable size and power consumption.

b. The turret hatch race contributes little to the leakage.

c. The main turret ring was found, in these tests, to contribute little leakage. The air flow through it depends upon the amount of grease in the ring.

d. Leakage around hatches and periscopes is easily reduced to a minimum.

e. These tests indicate that with a practical degree of sealing of present areas of leakage, a positive pressure can be maintained in the fighting

compartment with a ventilating system of moderate capacity and power consumption, provided the bulkhead between the fighting and engine compartments is completely sealed. Such a system, utilizing only space formerly wasted, has been installed in an M4A3 tank and is being studied to determine the internal pressure required for effective gas protection.

4. RECOMMENDATION:

That this report be transmitted to the agencies concerned with the gas-proofing of vehicles.

Submitted by:
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3 Incls.
#1 - Appendix
#2 - Table I
#3 - Figure 1

APPENDIX

Gas-proofing of the series M-4 tanks requires that the fighting compartment be provided with a pressure system of ventilation so as to maintain an outward flow of air through cracks and other leakage openings. During operation in a gas-contaminated area, the air must be passed through a suitable conditioning canister for removal of the contaminating gas. The capacity of a practicable system is necessarily limited by the space requirements of the fan, motor, gas canister and other appurtenances. It must, however, be adequate to maintain a pressure in the tank sufficient to prevent the ingress of toxic material. For a given positive pressure, the required capacity of the system is determined by the total area of leakage openings in the hull and turret. The bulkhead between the fighting and engine compartments must be sealed.

The purpose of the present tests was to determine the magnitude of the leakage through the tank as usually constructed and the practicability of sealing openings, particularly the more important leakage areas, to permit the use of a ventilating system of reasonable size.

Air was delivered into the tank through an orifice meter at measured rates and the corresponding static pressures within the tank determined. A pressure-volume curve was first obtained with the tank sealed as tightly as possible. Following this, specific leakage areas were unsealed and new pressure-volume curves obtained. The difference between two adjacent curves gave the pressure-flow curve for the leakage area in question. Because the work was done on a standard tank it was not possible to seal the bulkhead completely, and, as a consequence, an unknown quantity of air was constantly leaking through it. Since the flow through a given leakage area was obtained by difference. However, these measurements were not affected by the unknown leakage through the bulkhead. Pressure-volumes curves for the important leakage areas, obtained in this manner, are shown in Figure I.

The internal pressure required to provide protection against outside gas is not known at this time. To counteract the pressure of a 20-mile per hour wind would require a pressure of one-half inch water gauge, while one inch pressure would be effective at 30 m.p.h. or more. At these pressures, the air flow through the more important leakage areas in the M4A2 tank are given in Table I. It will be noted that the most important area of leakage is the 75 mm gun mount. The problem of sealing this point of leakage is complicated by the movement required in elevating and depressing the gun. It is believed possible, however, to reduce the leakage by suitable gaskets without interfering with the movement of the gun. Other leakage areas such as the turret and bow hatches are easily sealed by proper packing.

From these data it is concluded that the fighting compartment of the series M-4 tanks can be effectively sealed and maintained under a pressure of one-half inch water gauge, with a ventilating system of a moderate capacity which will permit its installation in the tank in space now available. This requires that the ventilation of the crew compartment be separated entirely from the ventilation of the engine compartment and that the bulkhead be sealed.

Encl #1

APPENDIX

Further investigation of this problem is under way and an M4A3 tank has been equipped with a system of positive ventilation for determination of the internal pressure required for effective gas protection. With only the bulkhead and ventilators sealed, an air flow of approximately 500 cfm has been found sufficient to produce an internal pressure of one-inch water gauge. With moderately effective sealing of the gun mount and other leakage areas, the air flow requirements will be reduced considerably below 500 cfm.

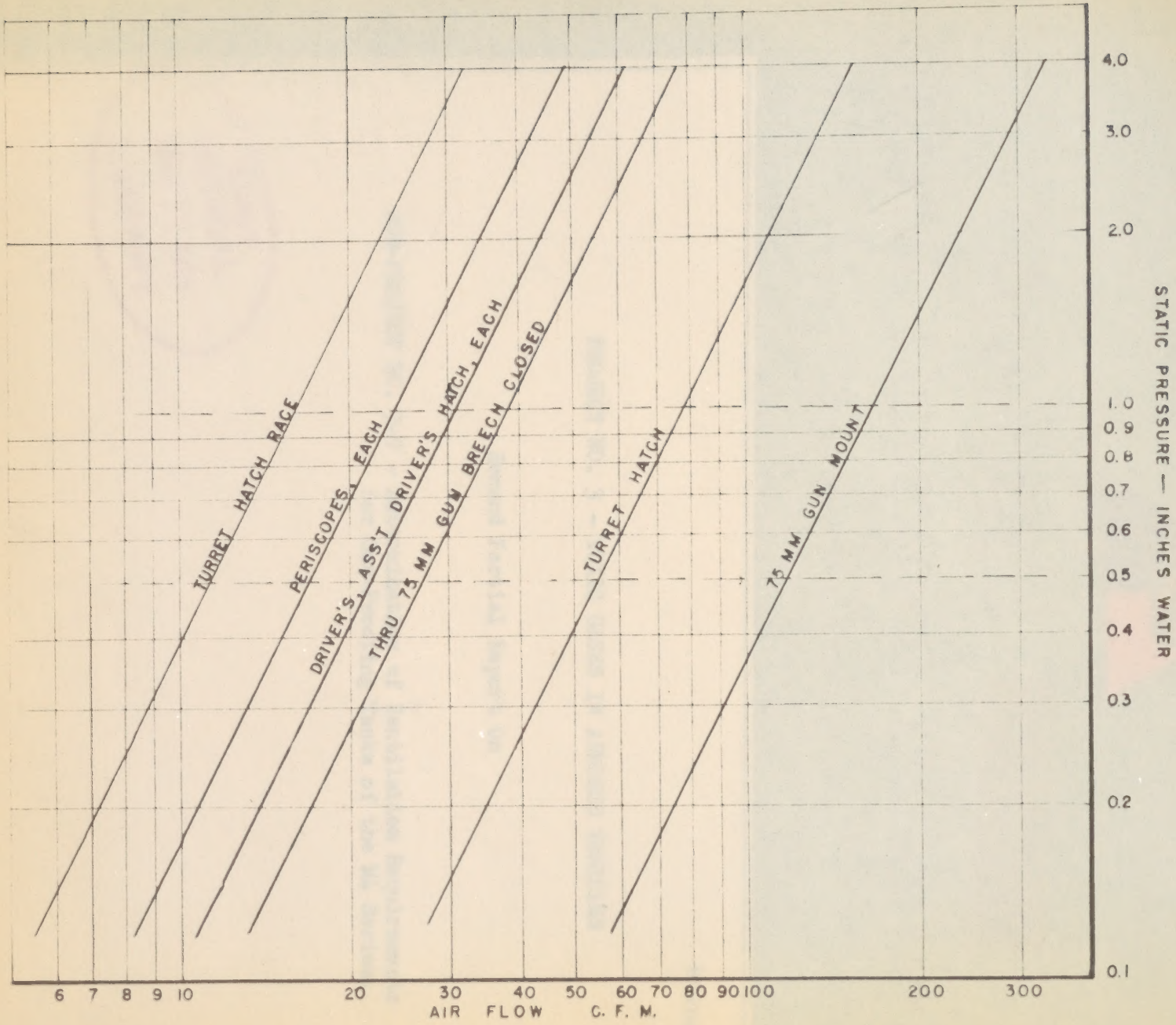
Encl #1

TABLE I

AIR FLOW THRU IMPORTANT LEAKAGE AREAS IN M4A2 Tank
AT ½" AND 1" STATIC PRESSURES

Leakage Area	Air Flow - Cfm	
	Static Pressure in Tank	
	½" Water	1" Water
Turret Hatch Race	12	16
Turret Hatch	54	77
Driver's and Ass't. Driver's Hatches	46	62
Periscopes (five)	85	120
75mm Gun Mount	116	165
Thru 75 mm Gun, Breech Closed	27	38
TOTAL	340	478

Encl #2



AIR FLOW THRU IMPORTANT LEAKAGE AREAS IN M4A2 TANK IN RELATION TO TANK PRESSURE

FIG. 1